

Design and Development of a Human Blood Type Detection System Based on the Internet of Things

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Abstract: Blood is an important component in the human body, acting as a means of transporting important substances such as sugar, oxygen, and hormones. Lack of blood can cause various diseases such as anemia, hypotension, and heart attacks. In situations such as accidents or childbirth, blood transfusions are needed to overcome blood deficiency. Blood transfusions must be carried out by considering blood types, including A-B-O and rhesus classifications, to prevent dangerous immunological transfusion reactions. Limited blood stocks, especially the rare rhesus negative type, are a challenge in maintaining blood availability. Current blood type detection still relies on the ability of the human eye and bioactive paper media, which are inefficient for large-scale testing and emergency conditions. This study aims to design a blood type detection tool based on the Internet of Things (IoT). This system consists of two main processes: data retrieval and data storage via the HTTP GET method. The tool will send data directly to a MySQL database locally, which can later be accessed via a website. The website will capture changes to the database using JavaScript. The test results showed that the system functioned well in the software trial, but experienced problems in the hardware test. However, the hardware test results showed an accuracy level of 93.33%.

Keywords: Internet of Things, ESP32, LDR, Blood Type Detection

1. INTRODUCTION

Blood is one of the most important components in the body, considering its function as a means of transportation as a supplier of important substances such as sugar, oxygen, and hormones [1]. Anaemia, hypotension, heart attacks are diseases when our bodies lack blood, so important is the blood in our bodies. Cases such as accidents, stab wounds, childbirth and anything that causes bleeding (reducing blood in the body) require blood transfusions. Blood transfusions cannot be arbitrary, there are 4 types of blood types that are known to date, namely A, B, AB, and O which are also often referred to as the A-B-O classification. Then there is also a rhesus classification system that has a positive or negative value. Rhesus in general (the majority) has a positive value so that someone with a negative rhesus value is very small in number. With a small number of negative rhesus, it becomes an obstacle in maintaining the availability of blood stock. Blood transfusions from incompatible groups can cause immunological transfusion reactions that result in haemolytic anaemia, kidney failure, shock, and death [2]. This certainly requires every human being to undergo examination and know their blood type. Blood type detection is done to find out the

blood type in the body. Currently, the method for detecting blood type is still done by using the ability of the human eye using bioactive paper media. However, the testing process takes a long time without storing donor data and is less effective if the blood being tested is in large quantities and in emergency conditions. From the problem above, researchers want to create or design a tool that can detect blood type using Internet of Things (IoT) technology. Based on the background above, the author is interested in submitting a research proposal entitled "Design and Construction of a Human Blood Type Detection Tool Based on the Internet of Things (IoT).

2. LITERATURE REVIEW

Research conducted by [3], refers to a tool made using a camera (image). Using an OV2640 camera embedded in the ESP32-CAM as a blood detector, the way this tool works is by processing image data with the TensorFlow Object Detection API framework, then the data is trained and its accuracy will be calculated using 20 datasets with a distance of 20 cm between the blood and the camera. The results obtained are mostly 100% accuracy for blood types A, B, AB, and O with

the conclusion that the more datasets used, the higher the accuracy value obtained.

Research conducted by [4], refers to a tool made using the ABO system method along with the rhesus system. Data is obtained by calculating the voltage value on the LDR sensor illuminated by the LED. Furthermore, the voltage value is processed by the Arduino Uno Microcontroller. Data can be seen on the LCD and Android smartphone application, using the Node MCU ESP8266 Wi-Fi module as data delivery in xls format. The test results obtained an average time for the device to detect data for 02.49 seconds and a delay of 20.37 seconds for data to be sent to the application. The percentage of accuracy of the device reading was 97.5% from 17 donors, blood samples were taken for 40 tests for each donor.

The research conducted by [5], refers to the design of an electronic blood type detection device with a digital display based on Arduino Nano. Each blood sample is placed on a glass slide and given antisera A and B which have been mixed with donor blood which will later be read by the LDR sensor. The data is displayed on a 16x2 LCD, and the test results can also be displayed on an Android smartphone using a Bluetooth network. Based on the test results, it can be concluded that the human blood type detection system can operate properly.

The research that the author will do has relevance to previous research, namely making a blood type detection device. Similar to the research conducted by [4] and [5], this tool is also made with an LDR sensor by detecting light passing through blood mixed with blood type antisera. However, this research also has differences with previous research, the tool made using an ESP32 microcontroller that uses a Wi-Fi network, uses OLED and the antisera used are anti-A, anti-B, anti-AB as a detection of ABO blood type and anti-D as a detection of rhesus which has positive and negative values.

A. Blood type

Blood type material is a blood grouping system based on the type of antigen it has. The antigen can be carbohydrates and proteins. The ABO blood group system was first discovered by Karl Landsteiner in 1900 by mixing erythrocytes and blood serum of his staff. Landsteiner, from the experiment found 3 of the 4 types of blood groups in the ABO system, namely A, B, and O. The fourth blood group, namely AB, was discovered in 1901 [6]. The factor that determines human blood type is an antigen found on the outer surface of red blood cells called agglutinin. Anti-antigen substances are called antibodies (agglutinins), namely natural antibodies found in serum, when reacting will agglutinate the antigen in question [7].

B. Blood reagent

Antisera reagent volume is a reagent used for ABO blood type examination. Obtained from in vitro supernatant culture originating from mouse cell immunoglobulin hybridization and the results of the examination will form agglutination [8].

The results of the combination of anti-A, anti-B, and anti-D reagent reactions to blood can be seen in table 1.

Table 1. Results of Reagent Combination Reactions to Blood

Anti Reagen A	Anti Reagen B	Anti Reagen D	Result
Clot	Clot	Clot	AB+
Clot	Tidak Menggumpal	Clot	A+
Not Clot	Clot	Clot	B+
Not Clot	Not Clot	Clot	O+
Clot	Clot	Not Clot	AB-
Clot	Not Clot	Not Clot	A-
Not Clot	Clot	Not Clot	B-
Not Clot	Not Clot	Not Clot	O-

C. Controller

ESP32 is the name of a microcontroller designed by Shanghai, China-based company Expressive Systems. ESP32 offers a standalone Wi-Fi network solution as a bridge from existing microcontrollers to Wi-Fi networks. LDR or Light Dependent Resistor is a type of resistor whose resistance value is influenced by the light it receives. The value of the resistance on the LDR depends on the amount of light received by the LDR itself [9]. Examples of its use are in garden lights and street lights that can turn on at night and turn off during the day automatically. Or we can also use it in our own room. OLED is one of the tools used as a medium to display data programmed from a microcontroller. The size is 29.28x27.1 mm 0.96" with a resolution of 128x64 so that it has a very sharp pixel contrast and does not require backlight and the power consumed is very efficient [10]. In Figure 3. Is an example of an OLED device used. A flowchart is a diagram that shows the steps or operations that occur in a system as a whole [11]. In addition, a system flowchart describes the order in which each system procedure is executed. A flowchart is a diagram that shows the logical development of a software or system process. Flowcharts are mostly used for documentation and as a communication tool. Internet of Things refers to a network of physical devices that are interconnected and able to communicate over the internet. The basic concept of IoT is to connect various everyday objects or devices to the internet, thus enabling the exchange of data between them automatically [12,13]. In the context of IoT, physical devices include various types of objects such as smartphones, smart home devices, connected vehicles, industrial sensors, medical equipment, and urban infrastructure. The working principle of IoT involves the use of sensors and monitoring devices to collect data and send it over the internet network [14-16].

3. METHODOLOGY

In Figure 1. below we can see that only 3 drops of blood are needed mixed with antisera reagent, then the mixture is placed on a glass slide. Then the device will read each drop of blood that has been mixed and classify the blood based on the data obtained from the LDR sensor light reading and displayed on the 0.96" OLED. Then the data is recorded into the cloud database and displayed on the blood type monitoring website.

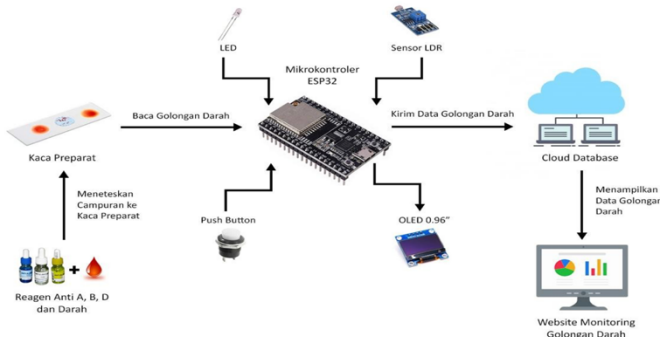


Figure 1. Block diagram of the system

The software specification will explain what is needed to create the software at the implementation stage. The software specification can be seen in table 2.

Table 2. Software specification

Software	Specification
Server (Local Host)	XAMPP v3.3.0
Operating system	Windows 10
Application programming	Arduino IDE 2.0.1
Browser	Google Chrome

In designing a tool, various tools are needed that are arranged into a prototype. Hardware specifications are needed to describe what is needed to build a prototype at the implementation stage. Hardware specifications can be seen in table 3.

Table 3. Hardware specification

Hardware	Specification
Microcontroller	ESP32 WROOM-32U
Light sensor	LDR (Light Dependent Resistor)
Light supply	White LED
LED display	OLED 0.96"
Trigger button	Switch Push Button A297
Mix liquid	Reagan Antisera Blood Type
Blood such tool	Pen Lancet Device GC
Blood media	Preparete Glass

Flowchart is a systematic presentation of the process and logic of information handling activities or a graphical

depiction of the steps and sequence of procedures of a program. A flowchart is a chart that shows the flow in a program or system procedure logically. Flowcharts are used primarily for communication aids and for documentation. Below is a flowchart image of the Design and Construction of a Human Blood Type Detector Based on the Internet of Things.

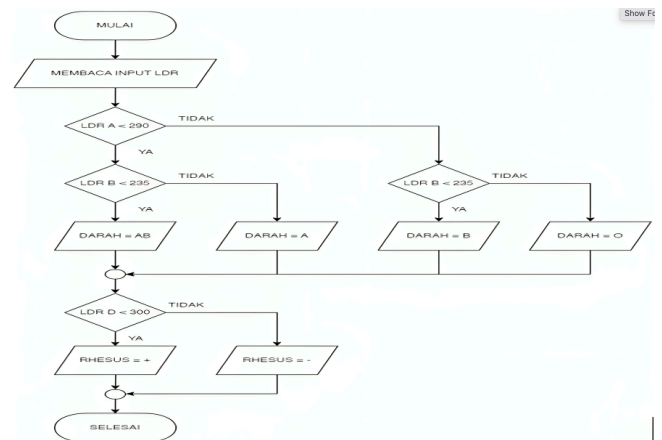


Figure 2. Flowchart of the system

3.1 Hardware & Software Specifications

Hardware Components:

- ESP32 WROOM-32U
- LDR sensors
- White LEDs
- OLED 0.96" Display
- Push Button
- Blood Reagent (Anti-A, Anti-B, Anti-D)
- Glass Slide, Pen Lancet

Software Tools:

- Arduino IDE 2.0.1
- XAMPP Server (Localhost)
- Google Chrome

3.2 System Flow

The system follows this process:

1. Collect blood and mix it with reagents.
2. Place the mixture on a slide.
3. LDR sensors detect light passing through the samples.
4. ESP32 processes the values and classifies blood type.
5. Results are displayed and stored in the database.
6. Web interface dynamically updates with new data.

4. RESULTS AND DISCUSSION

The results of the tool are designed by connecting the ESP32 microcontroller and other components, such as LDR sensors, LEDs, push buttons and OLEDs, which can be seen in the image below. The way the device works is by inserting blood into a place that contains 3 LDRs and 3 LEDs in it, so that later the LDR sensor will work to capture light and determine blood type based on the light level. The light level will affect the level of blood viscosity produced from the mixture of antisera reagents that have been mixed with the blood sample. Figure 3 shows the blood pressuring measurement.

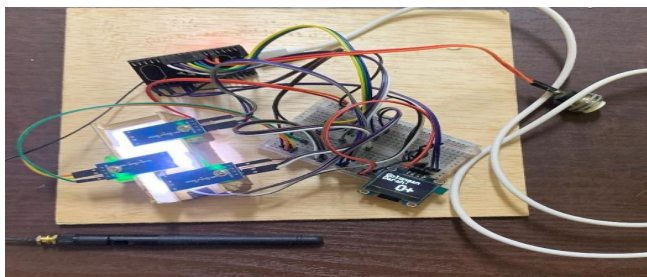


Figure 3. Prototype model of blood pressuring measurement

The software design produces a Blynk website that will display blood type information from the device to the website online. Here are some of the website displays on Blynk that have been designed.

A. Blood Type Data Page

The blood type data page is a page to display records or history of blood type data from donors. The blood type data page can be seen in Figure 4.

No	Tanggal Cek	Nama	Golongan Darah	Aksi
1	05 Oct 2023 11:08 WIB	Dinda Ilma	O+	Detail
2	05 Oct 2023 07:33 WIB	Aqila	A+	Detail
3	31 Aug 2023 02:05 WIB	Rizna Akmallyah	B+	Detail

Figure 4. Blood Type Data Page on Website

The blood type data page contains the check date, name, blood type, and action. The check date is the date a donor checks their blood type, the name is the name of a donor, the blood type is the blood type data of the donor, and finally the action where there is a link that will take us to the detailed blood type information page.

B. Blood Type Information Detail Page

The blood type information detail page is another page as additional information from donors. The blood type information detail page can be seen in Figure 7.

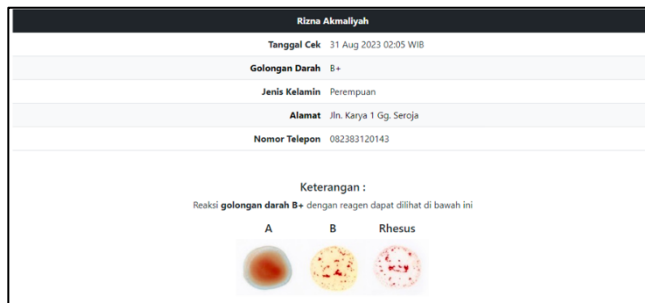


Figure 5. Blood Type Information Detail Page on the Website

The information page contains personal data from donors such as check date, blood type, gender, address, telephone number, and information. The detail page is displayed for other purposes such as checking addresses and is useful for explaining the reaction of blood mixtures with reagents.

C. Add Data Page

The add data page is a page for adding donor data who want to check their blood first. The add data page can be seen in Figure 8.

Figure 6. Add Data Page on the Website

The add data page contains an input form that functions as an input for the donor's name, gender, address and telephone number. There are 2 buttons, namely next and back. The back button will take us to the blood type data page and the next button will take us to the next page to wait for data (listen for device).

Software testing aims to determine the performance of the logic in the program. The software is tested directly on the working tool using the specified test parameters. The output of this study is a website that functions to display blood type data. The available pages include the blood type data page, the blood type information detail page, and the add data page. The software testing carried out can be seen in table 4. below:

Table 4. Results of measurement

No.	Functions Tested	Method	Expected Results	Results
1	Blood Type Data Page	Press the "detail" button on the website display dashboard page	Displays the detailed information page	As expected,
2	Add Data Page	Press the button on the tool	Displays blood type data description	As expected,

The system implements the results as expected, which means that all functions in the software run well. The software can display data and retrieve data correctly. So it can be said that the system or software that has been created is in accordance with user needs.

Hardware Testing Results In conducting hardware testing, there are several things that need to be prepared, namely blood samples, antisera reagents. Hardware testing is the result of testing a tool that has been assembled in such a way. In conducting hardware testing, there are several things that need to be prepared, namely blood samples, antisera reagents. Testing will be carried out using 30 blood samples by taking 3 drops of blood each. There are 3 stages carried out in this hardware testing, namely taking blood samples, mixing blood with antisera reagents, and blood type detection results. The results of hardware testing can be seen in table 5.

Table 5. Results of hardware testing

Blood Type	Donor Name	Detection Value (LDR)			Results
		Anti-A	Anti-B	Anti-D	
A	Aisyah	258	289	297	A+
	Akhmad Akbar Thoha	223	240	280	A+
	Desy Mutia Saragih	242	267	286	A+
	Nurlisa Andriani	262	272	292	A+
	Shvia Kinanti	252	270	281	A+

	Widy Utami Adha	267	253	280	A+
	Chici Syaflati Putri	281	278	293	A+
	Via Saragih	276	241	298	A+
B	Bagus Harde Yandi	320	275	291	B+
	Cici Wela Sari	292	231	288	B+
	Familindo Presi	298	225	293	B+
	Fitria Rahmadani	306	224	289	B+
	M Adi Saputra	311	206	256	B+
	M Rinaldi	292	201	272	B+
	Nur Shoimah Awaliyah	295	231	226	B+
	Uniyah	305	214	212	B+
Vania Nanda Safira	317	222	285	B+	
AB	Deila Faadhilah	314	220	290	B+
	Eka Mulyani Rezeki SHN	287	307	295	A+
	Muhammad Delvika	256	220	285	AB+
	Suci Syaiful Anif	251	219	242	AB+
O	Yesika Ayu Risma	312	303	280	O+

Dinda Ilma Syafriani	298	289	299	O+
Febri Ananda Kusuma	294	310	291	O+
M Iqbal	300	266	300	O+
Yogi Iranda	294	252	290	O+
Dwi Tamalla	304	264	201	O+
Neni Maryani	297	247	291	O+
Duyeh	313	238	260	O+
Afifa Nurhasna	300	289	301	O+

From the results of the tests conducted on the LDR sensor on blood sample data. The distribution of blood types that vary among the author's relatives provides a deeper understanding of the genetic diversity that exists in the family or immediate environment. In collecting 30 data, quite significant variations were found:

1. 6 people with blood type A+;
2. 5 people with blood type B+;
3. 3 people with blood type AB+, and
4. 6 people with blood type O+.

Interestingly, the absence of Rhesus negative (Rh-) blood type in the sample indicates a typical genetic proportion in the group of relatives tested. However, in the data collection process, there were irregularities in two data that turned out to be inconsistent with the original values. This factor is important because it affects the accuracy of blood type analysis and evaluation. Deila Faadhilah should have blood type AB+, but the test results showed blood type B+. Likewise, with Eka Mulyani Rezeki SHN who should have blood type AB+, but the test results showed blood type A+. It is important to note that the number of samples taken is 30, which is considered a significant sample size in statistical analysis. This number is a large enough representation to obtain a picture that is close to reality in the case of human blood type testing, especially when considering the variations that may exist in certain communities or groups. The process of data retrieval and storage that occurs in this testing system plays a crucial role in producing accurate output. The use of the HTTP GET method to send data

directly to the mysql database locally, which is later accessed by the website with the help of JavaScript, allows the system to update information in real-time. This is an important step in developing a responsive and reliable system. However, the test results showed a difference in performance between software and hardware testing. Although the software test showed satisfactory results, the hardware test showed a discrepancy in 2 data. However, from the 30 data evaluated, the system was still able to operate with an accuracy level of 93.33%.

5. CONCLUSION

From the results of testing the human blood type tool, the following conclusions were obtained: Sensor In designing a blood type detection tool with Internet of Things (IoT) technology, there are two main stages, namely data retrieval and storage via the HTTP GET method, which can be accessed via output on a website. Although the system is effective in software testing, there are limitations in hardware testing, especially related to the excessive number of blood samples and uneven mixing between blood samples and reagent fluids. Based on testing 30 data, this tool shows an accuracy level of 93.33%, illustrating reliable performance in detecting blood types using IoT technology.

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